Claims

1. A prime mover output control system, comprising

a) a prime mover, comprising a mechanical output comprising a rotational velocity and a torque; and

b) a generator, powered by said prime mover, and providing an adjustable torque load on said prime mover;

wherein said prime mover comprises a characteristic of acceleration and deceleration in response to said torque load on said prime mover, towards an equilibrium speed with said generator; and

c) a control mechanism electrically connected to said generator, comprising an input for signaling a system power output requirement, said control mechanism providing control over said adjustable torque load of said generator, said adjustable torque load being reduced when said rotational velocity of said prime mover is not sufficient to produce said power output requirement, said adjustable torque load being increased when said rotational velocity of said prime mover is in excess for the production of said power output requirement, to effect a product of prime mover rotational velocity and torque to substantially meet said system power output requirement.

2. The system of claim 1 wherein said control over said adjustable torque load, comprising a torque load decrease in response to a requirement of a system power output increase, and a torque load increase in response to a requirement for a system power output decrease.

3. The system of claim 1 wherein said control mechanism further comprising graphical or mechanical techniques for use in determining said torque load.

4. The system of claim 2 wherein said control over said adjustable torque load comprising adjustment of said torque load in response to a changed system power output requirement, in a single step.

5. The system of claim 4 wherein said generator supplying power to an electrical load, and further comprising an energy storage unit connected to said control mechanism, said energy storage unit for supplying said electrical load with said system power output requirement, substantially irrespective of prime mover output fluctuations caused by prime mover power output change.

6. The system of claim 4 wherein said generator supplying electricity to an electrical load, and further not comprising substantial electricity storage between said generator and said electrical load.

7. The system of claim 2 wherein said control over said adjustable torque load comprising adjustment of said torque load in response to a changed system power output requirement in a plurality of stages.

8. The system of claim 2 wherein said control over said adjustable torque load comprising adjustment of said torque load in response to a changed system power requirement, to a torque load beyond a torque load required to achieve said changed system power output requirement, and a restoration to said torque load required to achieve said changed system power output requirement, when said changed system power requirement is reached by said prime mover.

9. The system of claim 2 wherein said control mechanism comprising gearing between said prime mover and said generator.

10. The system of claim 2, further comprising an energy storage unit connected to said control mechanism.

11. The system of claim 2 wherein said generator supplying power to an electrical load, and wherein said control mechanism comprising electronic components for the adjustment of the current drawn from the generator, to effect control over the torque load of the generator.

12. The system of claim 11 wherein said electronic components comprising a power electronic load electrically connected between said generator and said electrical load, said power electronic load comprising a controllable current draw from said generator, wherein said torque load of said generator being directly related to said current draw.

13. The system of claim 12 wherein said generator comprising a direct current generator and wherein said controllable current draw of said power electronic load comprising a controllable relationship of current versus voltage from said generator.

14. The system of claim 12 wherein said generator comprising an alternating current synchronous machine and wherein said power electronic load comprising a control element for adjustment of said controllable current draw, based on a desired relationship between a sampled generator output current and a sampled generator output voltage.

15. The system of claim 12 wherein said generator comprising an alternating current synchronous machine and wherein said power electronic load

comprising a control element for adjustment of a frequency component of said power, providing said controllable current draw.

16. The system of claim 12 wherein said generator comprising an alternating current synchronous externally excited machine comprising fixed excitation, and wherein said input of said power electronic load from said generator comprising a controllable current versus voltage relationship comprising said controllable current draw.

17. The system of claim 12 wherein said generator comprising an alternating current synchronous externally excited machine having fixed excitation, and wherein said input of said power electronic load from said generator comprising a controllable frequency, providing said controllable current draw.

18. The system of claim 12 wherein said generator comprising an alternating current induction machine and wherein said input of said power electronic load from said generator comprising a controllable frequency, providing said controllable current draw.

19. The system of claim 12 wherein said power electronic load comprising an operating range comprising positive incremental resistance over part or all of said operating range.

20. The system of claim 19 wherein said power electronic load having
a) a threshold voltage; below said threshold voltage, said current draw is very low or nil, and above said threshold voltage, said current draw increases steeply versus voltage,
b) a threshold voltage adjuster for controlling said threshold voltage, and thereby, said current draw from the generator.

21. The system of claim 20 wherein said threshold voltage adjuster further connected to said input for signaling a system power output requirement, and further comprising graphical or mathematical techniques for determining said threshold voltage in accordance with said system power output requirement.

22. The system of claim 21 wherein said threshold voltage adjuster comprising means to increase said threshold voltage in response to an input signal describing a power output requirement increase, and means to decrease said threshold voltage in response to an input signal describing a power output requirement decrease.

23. The system of claim 14 wherein said power electronic load comprises a boost converter.

24. The system of claim 2 wherein said mechanical load comprising a generator supplying power to an electrical load comprising variable resistance, and wherein said generator being configured to have a torque load directly related to the current draw of said electrical load from said generator and wherein said control mechanism comprising control over said variable resistance to control said torque load.

25. The system of claim 24 wherein said generator being a direct current machine.

26. The system of claim 24 wherein said generator being an alternating current machine.

27. The system of claim 24 wherein said variable resistance comprising one or more variable resistors.

28. The system of claim 27 wherein said variable resistance comprising a plurality of fixed resistance resistors, and wherein said control mechanism comprising switches for switching different resistors in and out of a circuit to provide said control over said variable resistance.

29. The system of claim 28 wherein said variable resistors comprising variable resistance heaters.

30. The system of claim 2 wherein said generator comprising adjustable excitation, and wherein said generator being configured to have a torque load directly related to its excitation, and wherein said control mechanism comprising control over said adjustable excitation to control said torque load.

31. The system of claim 30 wherein said control mechanism comprising control over the relationship between the synchronous speed and the torque load of the generator

32. The system of claim 31 wherein said generator being a direct current independent wound commutated machine.

33. The system of claim 32 wherein said generator being a direct current independent wound brushless machine.

34. The system of claim 33 wherein said generator being an alternating current synchronous machine.

35. The system of claim 32 wherein said generator being an alternating current induction machine, and wherein said control mechanism comprising a quadrature current controller for varying the supply of quadrature current to the induction machine.

36. The system of claim 1 further including energy storage, and wherein said control mechanism comprising a power electronic load, wherein said power electronic load comprising an electrical input from said generator and being configured to control the current draw of said electrical input; thereby controlling the torque draw of the mechanical load; and wherein said energy storage connected to said power electronic load, and wherein said electrical load connected to said energy storage.

37. The system of claim 36 further comprising a controller having an input from said energy storage, and wherein said electrical load having an input from said controller, wherein said controller comprising control over the characteristics of the electrical input to said electrical load.

38. The system of claim 37, wherein said energy storage being a battery.

39. The system of claim 38, wherein said generator being a direct current or a rectified alternating current generator, and wherein said battery having a higher voltage than the voltage of said input of said power electronic load from said generator and wherein said power electronic load comprising a boost converter located between said generator and said battery.

40. The system of claim 39, wherein said generator being a direct current or rectified alternating current generator, and wherein said battery having a lower voltage than the voltage of said input of said power electronic load from said generator, and wherein said power electronic load comprising a buck converter connected between the generator and the battery.

41. The system of claim 38 further comprising a position sensing mechanism mechanically coupled to said prime mover, for commanding said control mechanism to apply an appropriate torque load at appropriate times during cyclic variations of said prime mover to mechanically assist said prime mover.

42. The system of claim 41, wherein said position sensing mechanism comprising a rotor position sensor.

43. The system of claim 38, wherein said generator being a brush commutated direct current generator or a brushless direct current motor modified with suitable backdiodes so as to be capable of generator operation and wherein said power electronic load comprising

a) the capability to source power from said energy storage, and

b) said electrical input to said power electronic load comprising an input voltage and an input current, said input current being controllable by said power electronic load to have current versus said input voltage characteristics that cause the automatic transition of generator to motor action and motor to generator action, around voltages related to said input voltage to have the following characteristics:

c) a high ratio of current draw to input voltage of above said threshold voltage, and a high negative ratio of current draw to input voltage of below said threshold voltage, whereby said generator transitions to motor action during reduced voltage periods that occur when said prime mover is engaged in substantially non power-producing periods.

44. The system of claim 43, wherein said power electronic load comprising a combination boost and buck converter connected between said generator and said energy storage.

45. The system of claim 38 wherein said power electronic load comprising current draw versus input voltage characteristics to cause a dynamic reduction of current draw from said generator during periods of reduced generator voltage.

46. The system of claim 38 wherein said power electronic load comprising a receptor for receiving a signal to start said system, and being configured to respond to said signal with the synthesis of suitable current and voltage characteristics for the sourcing of power from said energy storage to said generator, whereby causing said generator to act as a starting motor to said prime mover.

47. The system of claim 46 wherein said generator being a brush commutated direct current generator.

48. The system of claim 46 wherein said generator being a brushless direct current motors modified with suitable backdiodes so as to be capable of generator operation.

49. The system of claim 46 wherein said generator being a rectified alternating current generator and wherein said power electronic load comprising an input of controllable frequency.

50. The system of claim 1 wherein said generator having an excitation current of adjustable frequency, and wherein said control mechanism comprising a generator excitation control for controlling said

excitation current of said generator to effect control over said torque load on said prime mover; and wherein said system further comprising:

a) energy storage, connected to the output of said generator, and

b) an electrical load connected to said energy storage.

51. The system of claim 50 wherein said generator comprising an alternating current generator capable of motor operation, and wherein said generator excitation control for controlling said frequency of said generator excitation current, and comprising a power electronic load, connected between said generator and said energy storage, for the sourcing and sinking of power.

52. The system of claim 51 wherein said generator excitation control further comprising an input for receiving a signal to start said system, and comprising a programmed response to said signal of an increase in said excitation frequency from zero, and the sourcing of suitably synthesized current from said energy storage, and a startup heat source in said prime mover, in the case that said prime mover is of the type that requires a startup heat source to begin operation.

53. The system of claim 52 wherein said generator being an induction motor capable of acting as a generator, and wherein said generator excitation control comprising an inverter for synthesizing quadrature excitation current with an adjustable frequency for said generator.

54. The system of claim 53 wherein said generator excitation control comprising:

a) means to source current from said energy storage to power said generator as a motor, and

b) permitting a natural generator to motor transition during cyclic power output changes of said prime mover, whereby said generator acts as a motor during periods of substantially reduced prime mover torque output.

55. The system of claim 54 wherein said prime mover does not comprise a flywheel.

56. The system of claim 50 wherein said generator excitation control further comprising

a) an input for receiving a signal to start said system,

b) means to increase inverter frequency in response to said signal, and

c) a power electronic load connected between said generator and said energy storage, for causing said energy storage to supply operating power to said generator; whereby said prime mover may be started.

57. The system of claim 1 wherein said generator for generating alternating current and comprising electrical terminals, and wherein said control mechanism comprising a power electronic load, connected to said electrical terminals of said generator, said power electronic load comprising rectifier components, for converting alternating current to direct current, and wherein said power electronic load comprising control over the frequency of said alternating current, to effect control over said torque load of said generator on said prime mover; said system further comprising energy storage, connected to said power electronic load, and an electrical load, connected to said energy storage.

58. The system of claim 57 further comprising a controller electrically connected between said energy storage and said electrical load for supplying power to said electrical load at substantially the electrical requirements of said electrical load.

59. The system of claim 58, wherein said energy storage being a battery.

60. The system of claim 59 wherein said power electronic load comprising an inverter and a boost converter, electrically connected between said generator and said energy storage.

61. The system of claim 60 further including: a position sensing mechanism mechanically coupled to said prime mover for sensing the position of said prime mover during different parts of a prime mover power cycle, and connected to said power electronic load for commanding an increase in said frequency during parts of said prime mover power cycle during which said prime mover power output is substantially low or zero.

62. The system of claim 61 in which said increase in said frequency being sufficient to cause said generator to transition to motoring mode.

63. The system of claim 62 wherein said generator is an induction generator.

64. The system of claim 63, wherein said power electronic load comprising a current draw versus frequency characteristic being steep enough to cause a dynamic reduction of generator current draw during periods when said frequency of said electrical input of said generator is low.

65. The system of claim 64 wherein said prime mover comprising a heat engine and comprising a startup heat source, and wherein said generator being

capable of acting as a motor, and wherein said power electronic load being electrically connected between said electrical generator and said energy storage and comprising rectifier elements and comprising control over the frequency of said electrical current from said energy storage to said generator to power said generator as a motor and wherein said input for signaling a system power output requirement also for signaling to start said system power output requirement from zero, said signal for commanding to start said system power output requirement from zero for commanding the powering of said generator as a motor, until a synchronous speed is reached whereby said generator may be used as a starting motor to said prime mover.

66. The system of claim 61 wherein said power electronic load further comprising: a position sensing mechanism for commanding a the powering of said generator as a motor during time periods when said prime mover is engaged in a substantially non-power producing stroke.

67. The system of claim 1 further comprising energy storage and wherein said mechanical load comprising a generator, for supplying electrical power to an electrical load, and wherein said control mechanism comprising an electrical input from said generator and being configured to control the resistance of said input to effect control over said torque load; and wherein said control mechanism comprising an electrical output to said energy storage.

68. The system of claim 67 further comprising a controller, electrically connected between said energy storage unit, and said electrical load having control over the conversion of electrical power from said energy storage to said electrical load to substantially the electrical requirements of said electrical load.

69. The system of claim 68, wherein said energy storage comprising a battery.

70. The system of claim 69 further comprising: a position sensing mechanism for determining non-power producing prime mover power cycle portions and for commanding said control mechanism to produce a dynamic resistance increase substantially during non-power producing prime mover power cycle portions.

71. The system of claim 12 wherein said generator comprising a direct current generator and wherein said power electronic load comprising

a) voltage and current sampling means for sampling the input voltage and input current from said generator; and

b) an adjustable threshold voltage; and

c) means for comparing a scaled voltage proportional to said input current, with the amount of said input voltage above said threshold voltage; and,

d) a switching control element for controlling the current draw from said generator; and

e) means for adjusting said switching control element according to any differences between said scaled voltage and said voltage above threshold.

72. A method for controlling an engine to meet a power output requirement, comprising the steps of:

a) allowing the engine to run in an unthrottled condition,

b) receiving a signal describing a power output requirement,

c) varying the gear ratio of a transmission connected between the mechanical output of the engine and a mechanical load, to provide the engine with a load torque/speed characteristic having a torque equilibrium with the engine at an engine total power output level of substantially said power output requirement.

73. The method of claim 72 wherein said step of varying the gear ratio of the transmission comprising

a) meeting a power output requirement of maintaining a steady power output by setting the gear ratio of the transmission to provide a torque load to the engine that is equal and opposite to the engine torque output,

b) meeting an increased power output requirement by increasing the torque/speed gear ratio of the transmission,

c) meeting an decreased power output requirement by decreasing the torque/speed gear ratio of the transmission.

74. The method of claim 73 wherein said step of varying the gear ratio of the transmission comprising changing the gear ratio one gear at a time.

75. The method of claim 73 wherein the gear ratio of the transmission may be varied by individual gears and by groups of gears, wherein said step of varying the gear ratio of a transmission comprising

a) determining whether a large gear ratio change or a small gear ratio change is necessary, and in the event that a large gear ratio change is required, varying the gear ratio by a group of gears at a time, until not more than a small gear ratio change is necessary, and,

b) varying the gear ratio one gear at a time, until an equilibrium torque between the engine and the load on the engine, at substantially the power output requirement, is achieved.

76. The method of claim 75 in which the signal describing the power output requirement signals whether the power output requirement is greater than or less than the engine power output, and wherein each application of the steps of varying the gear ratio by a group of gears at a time and varying the gear ratio one gear at a time is followed by a wait in which the engine is allowed to change speeds towards a new torque equilibrium.

77. The method of claim 72 wherein the step of receiving a signal describing a power output requirement comprises determining a substantially exact power output requirement.

78. The method of claim 77 wherein the step of varying the gear ratio of the transmission comprising the step of determining and setting the gear ratio to the substantially exact ratio, to cause the load torque/speed characteristics, as reflected through the transmission, to come to an equilibrium with the engine at substantially the power output requirement.

79. The method of claim 78 wherein the step of determining comprising the step of using calculating or look-up techniques.

80. The method of claim 78 wherein the torque/speed characteristics of the engine are substantially linear or approximate to a curve, and wherein the step of determining the gear ratio assumes that the engine's torque/speed characteristics are exactly linear or exactly follow the approximate curve.

81. The method of claim 78 wherein an AC generator is connected to the transmission, for outputting AC power to an electrical load.

82. The method of claim 81 further comprising the step of providing an energy storage and wherein said AC generator supplies electrical power to said energy storage, and an electrical load draws the electrical power from said energy storage.

83. The method of claim 81 wherein said electrical load comprising a fixed frequency electrical load with a steep current/voltage characteristic, and wherein said method further comprising the step of allowing the fixed frequency electrical load to draw current according to its voltage.

84. A method for controlling the power output of an engine generator system, comprising
    a) connecting an unthrottled engine to a generator having more than three different electrical phases,
    b) connecting the electrical phases of the generator to inverter electrical phases with a mesh connection, and
    c) determining or receiving a signal regarding a required system output
    d) determining the generator current/voltage ratio at which the torque/speed characteristics of the generator would be in equilibrium with the torque/speed characteristics of the engine at substantially the required system power output, and
    d) implementing substantially that generator current/voltage ratio by using one or both of the following methods:
        i) switching the mesh connection to have a different skip number (S), and
        ii) superimposing or substituting temporal harmonics to the fundamental waveform of the inverter phases.

85. Apparatus for the control over the power output of an unthrottled engine, comprising
    a) a transmission, connected between a mechanical load and the unthrottled engine, comprising a variable gear ratio, and
    b) a control means, for controlling the torque load on the engine, according to a changeable required power output, comprising
        i) means for determining the torque output of the unthrottled engine at the achievement of a required power output, and
        ii) means for setting the gear ratio of the transmission to produce a torque load on the engine substantially equal in magnitude to the torque output of the unthrottled engine at the achievement of a required power output, whereby the unthrottled engine will reach an equilibrium with the mechanical load at substantially the required power output.

86. The apparatus of claim 85 wherein said transmission is a continuously variable transmission.

87. The apparatus of claim 85 wherein the control means comprises means to determine and set the substantially exact gear ratio required to produce said required power output.

88. The apparatus of claim 85 wherein said means for determining the torque output of the unthrottled engine at the achievement of a required power output comprising determining whether the torque output of the unthrottled engine at the achievement of a required power output is greater than or less than transient engine torque output, and wherein said means for setting the gear ratio of the transmission to produce a torque load on the engine substantially equal in magnitude to the torque output of the unthrottled engine at the achievement of a required power output comprising means to increase the torque/speed gear ratio when the required power output is greater than transient engine power output, and to reduce the decreased torque/speed gear ratio when the required power output is less than transient engine power output.

89. The apparatus of claim 85 wherein said mechanical load is a generator, connected to a battery.

90. A high phase order electrical rotating generator comprising windings connected to inverter output terminals with a mesh connection, and a logic level controller comprising means to add harmonics to the AC drive waveform of the inverter output terminals in order to vary the ratio between inverter terminal output current and windings current, according to a requirement for the rotating machine to produce varying total electrical output, wherein the greater the increase in ratio of inverter terminal output current to winding current, the greater the subsequent generator electrical output.

91. The high phase order electrical generator of claim 90, wherein said mesh connection may be changed with a mechanical switch.

92. The high phase order electrical generator of claim 90 wherein the mesh connection is such that windings filling stator slots that are approximately, but not exactly, 120 physical degrees apart on the stator, are connected to one another, and to the same inverter output terminal, and wherein said logic level controller comprising means to provide AC drive waveform of varying degrees of third harmonic and fundamental current.

93. The high phase order electrical generator of claim 90 further including an electrical energy storage medium connected to the output of said generator, and wherein said generator consisting of a motor/generator, having the characteristics of operating as a motor when winding currents are sufficiently low, and wherein said motor/generator able to source current from said energy storage medium in order to operate as a motor,

and wherein said logic level controller able to respond to a requirement for greater total generator electrical output, with a sufficiently high increase of the ratio of inverter terminal output current to winding current, to temporarily cause the generator/motor to operate as a motor, whereby the generator/motor will tend to speed up in operation and the generator/motor electrical output to subsequently increase.